

# COMBUSTION AND FLAME

## THE JOURNAL OF THE COMBUSTION INSTITUTE

VOLUME 117

NUMBER 1/2

APRIL 1999

### Contents

- J. M. BEÉR, J. B. HOWARD, J. P. LONGWELL (Cambridge, MA), and A. F. SAROFIM (Salt Lake City, UT)  
Obituary: Hoyt Clarke Hottel (1903–1998) ..... 1
- R. S. BARLOW (Livermore, CA), N. S. A. SMITH (Melbourne, Australia), J.-Y. CHEN (Berkeley, CA), and  
R. W. BILGER (New South Wales, Australia)  
Nitric Oxide Formation in Dilute Hydrogen Jet Flames: Isolation of the Effects of Radiation and Turbulence-  
Chemistry Submodels ..... 4
- ROBERT O. FOELSCHE, RODNEY L. BURTON, and HERMAN KRIER (Urbana, IL)  
Boron Particle Ignition and Combustion at 30–150 ATM ..... 32
- RONG F. HUANG and SHOW M. WANG (Taipei, Taiwan)  
Characteristic Flow Modes of Wake-Stabilized Jet Flames in a Transverse Air Stream ..... 59
- JAMES H. WERNER and TERRILL A. COOL (Ithaca, NY)  
Kinetic Model for the Decomposition of DMMP in a Hydrogen/Oxygen Flame ..... 78
- ALEXEI M. KHOKHLOV, ELAINE S. ORAN (Washington, DC), ALMADENA YU. CHTCHELKANOVA  
(Berkeley, CA), and J. CRAIG WHEELER (Austin, TX)  
Interaction of a Shock With a Sinusoidally Perturbed Flame ..... 99
- M. D. SMOOKE, C. S. MCENALLY, L. D. PFEFFERLE (New Haven, CT), R. J. HALL, and M. B. COLKET  
(East Hartford, CT)  
Computational and Experimental Study of Soot Formation in a Coflow, Laminar Diffusion Flame ..... 117
- G. G. DE SOETE, E. CROISET, and J.-R. RICHARD (Orléans, France)  
Heterogeneous Formation of Nitrous Oxide from Char-Bound Nitrogen ..... 140
- B. T. HELENBROOK and C. K. LAW (Princeton, NJ)  
The Role of Landau-Darrieus Instability in Large Scale Flows ..... 155
- CHING-JEN TANG, YOUNG JOO LEE, GAUTAM KUDVA, and THOMAS A. LITZINGER (University  
Park, PA)  
A Study of the Gas-Phase Chemical Structure During CO<sub>2</sub> Laser Assisted Combustion of HMX ..... 170
- PAUL-HENRI RENARD, JUAN CARLOS ROLON, DOMINIQUE THÉVENIN, and SÉBASTIEN CANDEL  
(Châtenay-Malabry, France)  
Investigations of Heat Release, Extinction, and Time Evolution of the Flame Surface, for a Nonpremixed  
Flame Interacting with a Vortex ..... 189
- FOKION N. EGOLFOPOULOS and CHARLES S. CAMPBELL (Los Angeles, CA)  
Dynamics and Structure of Dusty Reacting Flows: Inert Particles in Strained, Laminar, Premixed Flames ..... 206
- W. ZHOU, R. A. YETTER, F. L. DRYER, H. RABITZ (Princeton, NJ), R. C. BROWN, and C. E. KOLB  
(Billerica, MA)  
Multi-Phase Model for Ignition and Combustion of Boron Particles ..... 227
- CHING-JEN TANG, YOUNGJOO LEE, and THOMAS A. LITZINGER (University Park, PA)  
Simultaneous Temperature and Species Measurements of the Glycidyl Azide Polymer (GAP) Propellant  
During Laser-Induced Decomposition ..... 244

K. A. WATSON, K. M. LYONS (Raleigh, NC), J. M. DONBAR (Wright-Patterson Air Force Base, OH), and C. D. CARTER (Dayton, OH) Scalar and Velocity Field Measurements in a Lifted CH <sub>4</sub> -Air Diffusion Flame . . . . .	257
E. L. PETERSEN, D. F. DAVIDSON, and R. K. HANSON (Stanford, CA) Kinetics Modeling of Shock-Induced Ignition in Low-Dilution CH <sub>4</sub> /O <sub>2</sub> Mixtures at High Pressures and Intermediate Temperatures . . . . .	272
L. GASNOT, P. DESGROUX, J. F. PAUWELS, and L. R. SOCHET (Villeneuve d'Ascq Cedex, France) Detailed Analysis of Low-pressure Premixed Flames of CH <sub>4</sub> + O <sub>2</sub> + N <sub>2</sub> : A Study of Prompt-NO . . . . .	291
P.-A. BUI, D. G. VLACHOS, and P. R. WESTMORELAND (Amherst, MA) On the Local Stability of Multiple Solutions and Oscillatory Dynamics of Spatially Distributed Flames . . . . .	307
A. M. KHOKHLOV, E. S. ORAN (Washington, DC), and G. O. THOMAS (Aberystwyth, U.K.) Numerical Simulation of Deflagration-to-Detonation Transition: The Role of Shock-Flame Interactions in Turbulent Flames. . . . .	323
VIVEK SAXENA and STEPHEN B. POPE (Ithaca, NY) PDF Simulations of Turbulent Combustion Incorporating Detailed Chemistry . . . . .	340
P. BUCHER, R. A. YETTER, F. L. DRYER, E. P. VICENZI (Princeton, NJ), T. P. PARR, and D. M. HANSON-PARR (China Lake, CA) Condensed-phase Species Distributions about Al Particles Reacting in Various Oxidizers. . . . .	351
CHARLES S. McENALLY and LISA D. PFEFFERLE (New Haven, CT) Comparison of Non-Fuel Hydrocarbon Concentrations Measured in Coflowing Nonpremixed Flames Fueled with Small Hydrocarbons . . . . .	362
B. GOLOVANEVSKY, Y. LEVY, J. B. GREENBERG (Haifa, Israel), and M. MATALON (Evanston, IL) On the Oscillatory Behavior of Laminar Spray Diffusion Flames: Experiment and Theory . . . . .	373
INDREK S. WICHMAN (East Lansing, MI) On Diffusion Flame Attachment Near Cold Surfaces. . . . .	384
WILLIAM R. ANDERSON (Aberdeen Proving Ground, MD) Heats of Formation of HNO and Some Related Species . . . . .	394
C. H. Sohn, S. H. CHUNG, and J. S. KIM (Seoul, Korea) Instability-Induced Extinction of Diffusion Flames Established in the Stagnant Mixing Layer . . . . .	404
PHILIP J. SANTANGELO and IAN M. KENNEDY (Davis, CA) Droplet Lasing Spectroscopy Applied to Droplet Stream Flames. . . . .	413
AHMAD R. SHOUMAN and SAAD A. EL-SAYED (Las Cruces, NM) Accounting for Reactant Consumption in the Thermal Explosion Problem. Part IV. Numerical Solution of the Arrhenius Problem. . . . .	422
V. A. STRUNIN, A. P. D'YAKOV, and G. B. MANELIS (Moscow Region, Russia) Combustion of Ammonium Dinitramide . . . . .	429
Brief Communication	
N. P. TAIT (Chester, England) Soot Formation in Cracked Flames . . . . .	435
YU. N. SHEBEKO, A. YA. KOROLCHENKO, E. D. ZAMISHEVSKI, A. V. TRUNEV, V. YU. NAVZENYA, and A. A. ZAITZEV (Moscow Region, Russia) An Experimental Investigation of Blow-Out Limits for Hydrogen-Diluent Diffusion Flames. . . . .	438

J. C. HEWSON and F. A. WILLIAMS (San Diego, La Jolla, CA) Rate-Ratio Asymptotic Analysis of Methane-Air Diffusion-Flame Structure for Predicting Production of Oxides of Nitrogen. ....	441
B. VEYSSIERE and P. ARFI (Futuroscope, France), and B. A. KHASAINOV (Moscow, Russia) Detonations of Starch Suspensions in Gaseous $O_2/N_2$ and Stoichiometric $H_2/O_2$ Mixtures .....	477
VEBJØRN NILSEN and GEORGE KOSÁLY (Seattle, WA) Differential Diffusion in Turbulent Reacting Flows .....	493
R. O. S. PRASAD, R. N. PAUL, Y. R. SIVATHANU, and J. P. GORE (West Lafayette, IN) An Evaluation of Combined Flame Surface Density and Mixture Fraction Models for Nonisenthalpic Premixed Turbulent Flames. ....	514
S. S. SAZHIN, E. M. SAZHINA, M. R. HEIKAL (Brighton, UK), C. MAROONEY (West Sussex, UK), and S. V. MIKHALOVSKY (Brighton, UK) The Shell Autoignition Model: A New Mathematical Formulation .....	529
J. BUCKMASTER, T. L. JACKSON, and J. YAO (Urbana, IL) An Elementary Discussion of Propellant Flame Geometry. ....	541
A. TREGROSSI, A. CIAJOLO, and R. BARBELLA (Napoli, Italy) The Combustion of Benzene in Rich Premixed Flames at Atmospheric Pressure .....	553
MARIA LAURA MASTELLONE (Napoli, Italy), and UMBERTO ARENA (Caserta, Italy) Carbon Attrition During the Circulating Fluidized Bed Combustion of a Packaging-Derived Fuel .....	562
ZHENGHUA YAN and GÖRAN HOLMSTEDT (Lund, Sweden) Three-dimensional Computation of Heat Transfer from Flames Between Vertical Parallel Walls .....	574
T. R. BLAKE and J. B. COTÉ (Amherst, MA) Mass Entrainment, Momentum Flux, and Length of Buoyant Turbulent Gas Diffusion Flames. ....	589
YOUNGJOO LEE, CHING-JEN TANG, and THOMAS A. LITZINGER (University Park, PA) A Study of the Chemical and Physical Processes Governing $CO_2$ Laser-Induced Pyrolysis and Combustion of RDX .....	600
W. ŻUKOWSKI (Kraków, Poland) Acoustic Effects During the Combustion of Gaseous Fuels in a Bubbling Fluidized Bed. ....	629
M. S. CHA, D. S. LEE, and S. H. CHUNG (Seoul, Korea) Effect of Swirl on Lifted Flame Characteristics in Nonpremixed Jets. ....	636
WIWIK SUJANTI (Adelaide, Australia) and DONG-KE ZHANG (Auckland, New Zealand) Low-Temperature Oxidation of Coal Studied Using Wire-Mesh Reactors With Both Steady-State and Transient Methods. ....	646
Brief Communications	
MARTIN J. BROWN, DAVID B. SMITH, and SIMON C. TAYLOR (Loughborough, UK) Influence of Uncertainties in Rate Constants on Computed Burning Velocities .....	652
DAVID K. ZERKLE (Los Alamos, NM) Phase Segregation Effects on the Calculation of ODTX in HMX Spheres. ....	657



JACOB A. FRIEDMAN and METIN RENKSIZBULUT (Waterloo, Ontario, Canada) Investigating a Methanol Spray Flame Interacting With an Annular Air Jet Using Phase-Doppler Interferometry and Planar Laser-Induced Fluorescence . . . . .	661
A. MASSIAS, D. DIAMANTIS, E. MASTORAKOS, and D. A. GOUSSIS (Rio-Patra, Greece) An Algorithm for the Construction of Global Reduced Mechanisms With CSP Data . . . . .	685
DREW L'ESPÉRANCE, BRADLEY A. WILLIAMS, and JAMES W. FLEMING Intermediate Species Profiles in Low Pressure Premixed Flames Inhibited by Fluoromethanes . . . . .	709
S. SUBRAMANIAM and S. B. POPE (Ithaca, NY) Comparison of Mixing Model Performance for Nonpremixed Turbulent Reactive Flow . . . . .	732
YOSHIAKI HIDAKA, TOSHIHIDE NISHIMORI, KAZUTAKA SATO, YUSUKE HENMI, RIEKO OKUDA, KOJI INAMI (Matsuyama, Japan), and TETSUO HIGASHIHARA (Matsue, Japan) Shock-Tube and Modeling Study of Ethylene Pyrolysis and Oxidation . . . . .	755
C. G. FOTACHE, H. WANG, and C. K. LAW (Princeton, NJ) Ignition of Ethane, Propane, and Butane in Counterflow Jets of Cold Fuel versus Hot Air Under Variable Pressures . . . . .	777
YOUNGJOO LEE, CHING-JEN TANG, and THOMAS A. LITZINGER (University Park, PA) Thermal Decomposition of RDX/BAMO Pseudo-Propellants . . . . .	795
R. V. RAVIKRISHNA, CLAYTON S. COOPER, and NORMAND M. LAURENDEAU (West Lafayette, IN) Comparison of Saturated and Linear Laser-Induced Fluorescence Measurements of Nitric Oxide in Counterflow Diffusion Flames . . . . .	810
VLADIMIR M. ZAMANSKY, VITALI V. LISSIANSKI, PETER M. MALY, LOC HO (Irvine, CA), DARWIN RUSLI and WILLIAM C. GARDINER, JR. (Austin, TX) Reactions of Sodium Species in the Promoted SNCR Process . . . . .	821
MICHAEL R. HENNEKE, and JANET L. ELLZEY (Austin, TX) Modeling of Filtration Combustion in a Packed Bed . . . . .	832
EDWARD L. DREIZIN (Princeton, NJ) On the Mechanism of Asymmetric Aluminum Particle Combustion . . . . .	841
SHINJI HAYASHI, YUTAKA HISAEDA, YUUSUKE ASAKUMA, HIDEYUKI AOKI, TAKATOSHI MIURA (Sendai, Japan), HIROYUKI YANO and YASUHISA SAWA (Tokyo, Japan) Simulation of Soot Aggregates Formed by Benzene Pyrolysis . . . . .	851
C. J. BROWN AND G. O. THOMAS (Ceredigion, UK) Experimental Studies of Shock-Induced Ignition and Transition to Detonation in Ethylene and Propane Mixtures . . . . .	861
Short Communication	
W. J. SHEU and N. C. LIOU (Hsinchu, Taiwan) Transition of Ignition between Laminar Premixed and Nonpremixed Jets . . . . .	871
Volume Contents	